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PROBLEM OF ACCIDENT PREVENTION AT SMALL METAL MINES

BY

E. A. ANUNDSEN

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

PROBLEM OF ACCIDENT PREVENTION AT SMALL METAL MINES[1/]

By E. A. Anundsen[2/]

During the past 10 years the accident-prevention efforts of Federal, State, and insurance agencies, mine associations, individual mine operators, and mine-employee groups have been rewarded by a substantial decrease in the accident rate at metal mines, and certain mining operations have established accident records that compare with the best of those in industries believed to have far fewer inherent hazards than mining. Nevertheless, the accident rate for the mining industry as a whole remains definitely worse than that of most other industries.

Since some individual metal-mining companies have reduced accidents so successfully that one or two disabling accidents a year are considered a setback, it is evident that the poor showing of the metal-mining industry as a whole is due to the fact that many other metal-mining companies are not enjoying reasonably favorable accident experience. The best accident rates usually are established at large mines because they have the incentives of reduced direct cost (many large mines carry their own insurance), reduced indirect cost, more efficient operation, improved employee and public relations, reduced turn-over, and last but by no means least humanitarianism. With such incentives, accident-prevention efforts are logical, and where the work is done efficiently good results usually follow.

The success realized by a safety program usually is in direct ratio to the amount of well-thought-out determination to reduce accidents displayed by the management, and the successful accident-prevention program at the large operation usually is based upon capable and adequate supervision, employee education and training, and the installation and maintenance of safe practices and equipment. To develop these factors, the accident-prevention program generally embodies some or all of the following:

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7147." Presented at the Mining Session of the Western Safety Conference, Phoenix, Ariz., October 17, 1940.

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1. Training in foremanship.
2. Meetings of employees.
3. Safety committees.
4. Operating codes.
5. Accident investigations.
6. Safety inspections.
7. First-aid training of all employees.
8. Careful attention to engineering design of equipment and installations.
9. Adequate guarding of equipment, walkways, etc.,
10. Safety rules and regulations.
11. Enforcement of safety rules and regulations.

Such a program implies the availability of a number of competent men, including supervisors, safety engineers, mining engineers, and skilled labor, who in at least some instances must be paid for time devoted to safety as well as for time spent in their regular duties. It also implies that, although financial returns are to be expected, a considerable sum of money must be expended first to initiate a safety program.

The following information was compiled to compare the accident experience of large-mine operations where accident prevention is being attempted in varying degrees with that of small mines where little or no effort is made to prevent accidents.

Based upon underground employment only, Arizona mines were divided tentatively into two groups. Those employing fewer than 50 men underground on all shifts were classed as small mines, and those employing more than 50 men underground on all shifts were classed as large mines. This proved a convenient division, as the former were found to average about 11 underground employees to the mine and the latter about 250. Upon this basis, an average of 64 of the small mines of Arizona employed fewer than 16 percent of the total number employed underground during the period 1934 to 1939, while an average of 11 large mines employed more than 84 percent during the same period3/; yet the small mines suffered 41 fatal accidents, or more than 40 percent of the total fatal mine accidents, and the large mines 60 fatal accidents, or slightly less than 60 percent of the total. In Arizona the accident rate at small mines is far out of proportion to the employment when compared with that at the large mines, and it is probable that the direct cost of accidents per $100 pay roll at small mines is about twice as high as that at large mines.

There are, of course, numerous small mines in Arizona that have low accident rates. However, these good records are not always continued over a long period; furthermore, the good records of some small operations

3/ State of Arizona, Mine Inspector's Reports for Years 1934 to 1939. (Figures are based upon fiscal years ended November 30.)

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are offset by equally bad records of other small operations during the same period. Actually, in a subsequent year the position of some small mines might be reversed as far as the accident rate is concerned. This condition is due to the fact that no safety program or at least no sustained safety program, is in effect at most small mines.

The lack of organized effort to reduce accidents at small mines probably is due chiefly to the following:

1. Compensation insurance is paid at a fixed rate, regardless of accident experience; thus there is no apparent financial advantage in accident prevention.

2. Operating capital is limited, and usually the operator believes that he does not have enough funds to carry on a safety program.

3. The operation of small mines frequently is intermittent, and labor turn-over is likely to be high; hence the effect of a safety program may be lost at each shut-down.

4. Small operators cannot afford to employ a man who is informed on safe practices and equipment and capable of carrying out the work ordinarily performed by a safety engineer at large properties.

5. Small mining operations often are conducted by persons unfamiliar with mining, mining problems, or the need for accident prevention; such persons sometimes are forced on the local manager because of relationship to stockholders, but they may be employed through misjudgment by the owner or because they will accept low wages.

The preceding seems to hold little hope for improvement of the accident rate at small mines, yet further consideration of these obstacles indicates that they are not only surmountable but that even a minimum of effort devoted to accident prevention is likely to be rewarded substantially.

ACCIDENT-PREVENTION DIVIDENDS

The total cost of an accident includes the costs of compensation, medical services, repairing or replacing equipment or material damaged by the accident, loss in production at the time and place of the accident, lost production until the injured man's replacement reaches top efficiency, and other items.

Unfortunately, at small mines (and also at some large ones) all such costs except compensation and medical service are thrown into the operating cost, so that the operator loses sight of them and fails to realize how much accidents have raised his cost per ton of ore; moreover, in many small mines little or no cost accounting is done. These concealed costs have been estimated to be four or five times the cost of compensation, and unquestionably they aggregate at least two or three times the compensation and medical cost.

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At small operations compensation and medical costs usually are disguised in the form of a fixed insurance rate. Many small-mine operators do not know what sums have been paid out to disabled employees and to their doctors, yet the insurance rate depends directly on these payments, and if small mines as a group reduced their accident rate the insurance rates probably would be reduced also.

In some localities dividends are paid by the insurer to the mine operator when the latter complies with certain safety requirements, and in other localities dividends are returned to the operator when compensation claims of the employee and medical claims of the doctor have been sufficiently below the insurance premium paid to the insurer. Thus a small-mine operator has an excellent opportunity to realize financial gain through accident prevention by cutting operating cost, reducing the premium rate of the group, and participating in insurance dividends. (Since this paper was presented information has been received from an insurance agency in Arizona that from April 1, 1939, to March 31, 1940, the percentage of claim loss to premium earned was 105, while during the period April 1, 1940, to September 30, 1940, when a safety director was employed, the figure was reduced to 41.1 percent.)

It is not assumed, however, that this improved accident rate can be attained without effort, and a small-mine operator is likely to be discouraged by visions of paying for a relatively elaborate safety program like that carried on by large mining companies. A safety program designed to fit the small operation must therefore also fit the operator's pocketbook.

ECONOMICAL SAFETY PROGRAM FOR SMALL-MINE OPERATORS

Fortunately, the simplicity of the small operation compared with the complexity of the large one usually allows corresponding simplicity in a safety program, although the program's success depends on the same vital factor as that of the large operation - the management's belief (which costs nothing) in safety and its determination to achieve a low accident rate.

The program itself boils down essentially to two constituents - a competent supervisor and safety education of the employees. Supervision refers to that of the person in direct charge of mining, as the mine foreman or shift boss, or both if more than one is employed. Safety education involves, first, instilling into the minds of employees a desire to work safely; second, teaching them how to do it; and third, requiring that it be done and possibly giving them some extra incentive for working safely.

Competent supervision frequently is lacking at small mines; able bosses are not attracted by the low pay and uncertain future at most small mines. On the other hand, employment of incompetent bosses is expensive economy, for not only are accidents likely to increase, but the cost of operation due to poor mining practices and methods also

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increases. Many current mine operators can point to the harm done to an otherwise promising operation by previous operators who, as a result of haphazard mining, "lost their shirts." Unfortunately, some of the critics are following the same path.

Where mining is concerned it should be obvious that a competent foreman is absolutely essential. The additional money spent to retain the services of such a person is an intelligent investment, as with such a foreman the possibility of reducing the number of accidents is good and the future for such a mine will be brighter. Adequate supervision, although requiring greater initial outlay, is ultimately economical.

Employees may be educated in safety at little expense. They first must be convinced that accidents not only are highly undesirable from their standpoint but also are preventable. A course of training that will vividly show them the consequences of injury already is available in first-aid instruction, and such training has the additional advantage of teaching employees to care for injured fellow workers, thereby enabling them to save lives and alleviate the consequences of injury.

Accident-prevention discussions conducted as part of this training or following it are very effective in reducing accidents, as employees are then in a receptive frame of mind and readily see why as well as how accidents can be prevented.

First-aid training is available to employees essentially without cost to the mine operator; it is conducted by Federal and State agencies and by private insurance companies. Most of such training now is conducted at large mining operations for several reasons: The operators of large mines request it, excellent cooperation is offered the agency conducting the training, and a large number of employees are easily available for the training. In contrast, the operator of a small mine frequently does not desire the training until he is in desperate straits, and often cooperates unsatisfactorily, if at all, so that the agency conducting the training sometimes wastes time and money that could have been spent to better advantage in reaching a larger number of men at large mines. The fact remains that these first-aid training agencies are willing at all times to work with operators of small mines, provided they are willing to do their part and do not expect the cooperating agency to accomplish miracles unassisted.

First-aid training of all employees frequently will produce an immediate and decided reduction in accidents, but this reduction is likely to be temporary unless additional long-range safety activity is carried on. A satisfactory accident rate can be maintained by an active employee safety organization; if the employment is small this organization also may act as a safety committee; and if 20 or more men are employed, a safety committee may be formed to represent the group.

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An effective safety committee includes the mine foreman, all other bosses employed on the surface or underground, and employee representatives equal in number to the supervisors. The highest official at the mine (manager or superintendent) acts as committee chairman. If more than one shift is employed, the safety committee may be split into sub-committees on each shift. For example, a mine employs two shifts, and a mine foreman, shift boss, top boss, and mill foreman are employed on the day shift; these men are made permanent members of the safety committee. At a meeting of employees the names of men who will volunteer to serve on the safety committee are submitted to the group, and four employees (three from the mine and one from the surface) are elected to serve. Thus the committee is composed of four employees, four bosses, and the manager or superintendent. A similar committee is formed on the other shift, with the mine foreman and manager or superintendent also included as members of the second committee. Employee members are rotated and draw lots to determine their tenure. If the committee originally has four employee members they may serve 1, 2, 3, and 4 months, respectively, at first, and all subsequent employee members will have a tenure of 4 months; only one employee member will be replaced each month, and new members will have the guidance of those familiar with committee activities. The committees may meet twice monthly, and all employees can meet once monthly. As committee members are volunteers no expense should be attached to their activities, and the monthly safety meetings of all employees can be made interesting enough to insure attendance of most of them even though the meetings are held after working hours.

Activities of the committee should include some or all of the following:

1. Investigation of accidents. - The committee should inspect the scene of each accident; interview witnesses and also the victim (if possible); determine the cause, responsibility, and method of prevention; and prepare and post a report.

2. Safety inspections. - Selected members of the committee should make a trip through the mine and surface plant once a month and prepare a report on unsafe conditions and practices observed.

3. Safety rules. - Safety rules should be prepared by the committee. These rules should be practical, and provisions should be included for enforcing them. They should be submitted to the employees for suggestions and approval and be put into effect as soon as approved.

4. Safety suggestions. - Safety suggestions should be solicited from the men, and the committee should consider and pass on them. The donor should be advised as to the action taken on his suggestion, and if the suggestion is rejected he should be given a reason for the rejection.

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5. Reports. - Accident and inspection reports should be posted and verbal statements on the activities and accomplishments of the committee should be made at the monthly employee safety meetings.

At the mine employing only 5 or 10 men, the entire personnel can be included in the safety committee.

Some mining operations have been able to establish reasonably good accident records through good supervision alone, and it must be admitted that good supervision is very important. The best, most consistent, and most easily attained good accident records, however, have been achieved only after the employees have been assigned a definite place in the accident-prevention program. In fact, the employees themselves can be depended on to accomplish a decided reduction in accidents if given a responsible part in the safety program, provided the management will cooperate in their activities. Employee safety organizations in numerous instances have proved reasonable, fair, and helpful, especially when the employees have understood that accident reduction is mutually beneficial.

PRACTICES AND EQUIPMENT AT SMALL MINES

Although poor methods and unsafe practices remain the greatest cause of accidents at small mines, these are the factors that cost least to correct. However, inadequate, poorly maintained, defective equipment, plus poor maintenance, lack of timber, lack of proper tools, etc., also contribute to the high accident rate at small mines. These factors are important because they may add more to the cost of mine operation than unsafe practices. Limited capital is certainly an obstacle to the possession of adequate equipment, although lack of foresight and unwisely spent capital are among the principal reasons for much of the poor equipment many small mines are forced to use.

Unsafe practices and equipment observed at small mines include the following:

Shafts and Hoisting

(2 men killed in Arizona small mines 1934-1939, inclusive)

Unsafe practices	Lack of or unsafe equipment
1. Hoisting cars on inclines without using drags to prevent cars running back down inclines if cable, cable attachment, coupling, or hoist fails.	1. Poor band brakes on hoists; no emergency brake or device able to hold the load if the brake fails.
2. Rock-spillage accumulations or shaft timber not cleaned down.	2. No safety catches on skips or cages; safety catches not tested at regular intervals.

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3. Men working on inclines below active hoisting operations without protection of bulkheads or other means of arresting a car, or cars, that may break loose.

4. Mining too close to the shaft.

5. Men riding bails of buckets and skips.

6. Skips or cages overcrowded when hoisting and lowering men.

7. Men riding cages, skips, or cars with tools, explosives, and other material.

8. Storage of inflammable material such as gasoline, oils and other lubricants near the shaft in the hoist house.

3. Hoist cables not lubricated or inspected; old, rusty, and possibly defective cables in use.

4. Hoists not equipped with indicators or other safety devices.

5. No gates, railings, or bars at shaft stations.

6. No gates on cages.

7. No derails at top of inclines.

8. Poor shaft or incline signaling systems.

9. Poor power units on hoists, such as salvaged automobile engines or gasoline engines installed so as to allow exhaust gases to enter the hoist room.

10. No fire-fighting equipment on the surface.

Rock-Fall Hazards

(12 men killed in Arizona small mines, 1934-39, inclusive)

Unsafe practices

1. Men working and allowed to work directly under rock known to be loose.

2. Loose rock allowed to remain over manways and in regularly traveled drifts and crosscuts

3. Loose gouge or vein material in stopes not timbered up or taken down.

Lack of or unsafe equipment

1. Miners not provided with good bars and required to pull down loose rock with picks.

2. Insufficient or too small timber furnished.

3. Booms and hangers not furnished for driving drifts in bad ground.

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4. First consideration to "getting the round in" and not to making the working place safe.

5. "Get the round in or we'll hire someone who can" policy followed by some bosses.

6. Timber not kept up to face in bad ground.

7. Stulls not hitched into walls where possible and stulls poorly blocked.

8. Sets poorly alined, poorly lagged, poorly blocked, and poorly framed.

9. Inadequate support for filled stopes where collapse of timber would result in filling drifts that are in use.

10. Failure to leave cushion of rock on timber of emptied shrinkage stopes.

11. Inadequate or indifferent supervision.

12. Improper mining method (mining without support ground that should be supported).

Fall-of-Person Hazard

(10 men killed in Arizona small mines, 1934-39, inclusive)

Unsafe practices	Lack of or unsafe equipment
1. Throwing steel and other material down manways, damaging same.	1. Continuous ladderways without platforms.
2. Failure to report hazardous conditions in manways.	2. Unguarded openings in drifts and stopes.
3. Failure to warn miners working above when pulling chutes.	3. Small manways obstructed by pipe, timbers, etc., making passage difficult.
4. Working floors not kept clean.	4. Rungs broken or missing from ladders.

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5. Careless flooring of sets and neglect to nail flooring.	5. Hand rails not provided where desirable.
6. Projecting nails and other tripping hazards not removed.	6. Poor material used for stagings.
7. Failure to establish firm and safe footing.	7. Insufficient lagging for working floors.
8. Safety ropes and safety belts not worn where required.	8. Ropes and safety belts not provided where necessary.

Explosives

(14 men killed in Arizona small mines, 1934-39, inclusive)

Unsafe practices	Lack of or unsafe equipment
1. Opening cases of explosive with metal tools.	1. Poorly constructed and poorly maintained magazines located too close to roads, dwellings, or mine buildings.
2. Using open lights in magazine and in direct proximity to explosive.	2. Magazine not provided with safe lighting facilities.
3. Transporting capped fuse and explosive together in an open box.	3. Metal tools furnished for opening cases of explosive.
4. Riding on skips or cages with explosive.	4. Short fuse provided.
5. Slitting primer cartridges.	5. Improper fuse provided.
6. Lacing, bending back, or otherwise causing sharp bends in fuse.	6. Poor or not enough sacks or containers furnished for transportation of explosives.
7. Tamping primers and explosive unnecessarily hard.	7. Substandard switches and wiring used for electrical blasting.
8. Spitting fuse without trimming for rotation.	8. Electrical detonators obtained without short circuited leg wires.
9. Cutting off too much fuse when trimming for rotation.	9. Testing equipment for electrical detonators or blasting circuits not provided.
10. Staying too long when spitting.	

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11. Failure to count shots and report misfires.

12. Returning too soon after blasting.

13. Drilling, mucking, timbering, or doing other work in the vicinity of misfires before disposing of them.

14. Attempting to remove misfired charges by digging them out or pulling them.

15. Caching or hiding excess explosive or explosive recovered from the muck pile.

16. Failure to guard shots.

Miscellaneous

(3 men killed in Arizona small mines, 1934-39, inclusive)

Unsafe practices

1. Lack of cooperation among employees, particularly between opposite shifts ("Let the other shift do it" policy).

2. Men not trained in first aid or mine rescue.

3. New employees insufficiently instructed or supervised.

4. Poor housekeeping.

5. Failure to report unsafe equipment, conditions, etc.

Lack of or unsafe equipment

1. Miners not provided with hard hats, goggles, or protective shoes or boots.

2. Electrical circuits not properly protected or poorly installed.

3. Ventilating equipment not provided or inadequate.

4. Sprinkling equipment not provided or inadequate.

5. Mine rescue crews or equipment not provided.

6. Mechanical equipment inadequately guarded.

In connection with employees, it is observed further that many of those now working at small mines are totally inexperienced or inclined to overrate their experience; it is an unfortunate fact that frequently too few experienced men are available at a given mine to make possible the "apprenticeship" system formerly used in mines. This situation can be relieved greatly by the efforts of an active safety committee.

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The above conditions, actually observed in small mines, are indicative of the conditions that establish an accident ratio between large and small mines that definitely is unfavorable to the latter. A study of this list will show nearly all items to be readily correctible, and that to remove most of the factors contributing to the high accident rate at small mines will require little more than a determination to reduce accidents, the cooperation of the men, and a relatively inexpensive program of education. If the unsafe practices alone were eliminated, the small-mine accident rate would greatly decrease, and with reasonable improvement in equipment the accident rate should compare favorably with that of other industries.

CONCLUSION

Small-mine operators have much to gain by a progressive attitude toward accident prevention, and they can achieve a decided reduction in accidents through the following steps:

1. Adopting the policy that accidents can and will be prevented.

2. Employing a competent mine foreman.

3. Training all employees in first aid.

4. Organizing safety committees and encouraging them to carry on a safety program such as that outlined.

5. Making sure that new employees receive the necessary instruction, training, and supervision to render them safe workemen.

6. Obtaining the assistance of private, State, and Federal agencies engaged in accident-prevention work.

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